

Sediment drifts in Lago Castor (Chilean Patagonia) reflect changes in the strength of the Southern Hemisphere Westerly winds since the Last Glacial Maximum

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Abstract: Lago Castor (45.6°S; 71.8°W) is located within the postglacial pathway of the core of the Southern Hemisphere Westerly winds, which migrated from ~42°S during the LGM to ~52°S at present. During two field expeditions (2009-2011) a network of high-resolution reflection-seismic profiles of the lake infill was acquired and a 15 m long composite sediment core was retrieved. The combination of the seismic stratigraphy and the sediment core lithology shows that the lower units were deposited in a proglacial environment, while the upper units (younger than 18.3 kyr BP) were influenced by bottom currents counteracting currents of surface waters driven by the Southern Hemisphere Westerlies. We conclude that sediment drifts constitute a good and relatively poorly investigated proxy for Westerly wind strength reconstructions.

Key words: lake sediments, Southern Hemisphere, Westerlies, Chile, Holocene

INTRODUCTION

Variations in the latitudinal position and strength of the Southern Hemisphere Westerly Wind Belt (SWWB) have strongly determined climate fluctuations in Patagonia since the Last Glacial Maximum (LGM). Reconstructing variations in the strength and/or latitude of the SWWB, however, requires an array of paleoclimate records located along a north-south transect. Lago Castor (45.6°S; 71.8°W) is located within the postglacial pathway of the core of the Westerlies, which migrated from ~42°S during the LGM to ~52°S at present. Lago Castor is a glacial lake on the eastern side of the Andes mountain range in Chilean Patagonia, and it contains a sedimentary record encompassing the entire Holocene and deglaciation.

METHODS

During a first expedition in 2009, a dense network of high-resolution reflection-seismic profiles (3.5 kHz and sparker) of the lake infill was acquired. The seismic profiles were analysed using IHS Kingdom software. In the austral summer of 2011, a 15 m long composite sediment core was retrieved using a UWITEC piston coring system. After opening and description, pictures were taken and magnetic susceptibility was measured at 2.5 mm intervals (Bartington MS2E point sensor), organic matter content has been estimated using loss-on-ignition, and grain-size analyses of the terrigenous fraction (pre-treatment with H₂O₂, HCl and NaOH; Malvern Mastersizer 3000) were performed every ~10 cm. The core chronology was based on nineteen ¹⁴C dates.

RESULTS

The sediment core penetrates into the lower units (E and F) of the sedimentary infill of the lake, which is characterized by a ponding, semi-transparent seismic facies (FIGURE 1). The sedimentary facies consists of layered to laminated clays to fine silts with a very low organic matter content. The top of unit E was dated to ~18.3 kyr BP.

The upper part of the lake infill (units A-D) consists of draped to mounded sediment packages, with fluctuations between both end-members (FIGURE 1). This unit corresponds to the upper nine meters of the sediment core. The green-brown laminated sediments are richer in organic matter and are composed of fine to coarse silts. They are also frequently interrupted by coarser grained volcanic-ash layers characterized by high magnetic-susceptibility values.

DISCUSSION

The combination of the seismic stratigraphy and the sediment core lithology shows strong changes in sedimentary processes (FIGURE 1). When the laminated sediments of units E and F were deposited, Lago Castor was a proglacial lake. The lake received high amounts of fine-grained sediments from the Patagonian Ice Sheet outlet glaciers, resulting in typical glacial varves.

On the contrary, the draped sediments from units A-D can be attributed to hemipelagic sedimentation under calm conditions. The mounded packages are interpreted as sediment drifts in which sedimentation is strongly influenced by bottom currents. In lakes Cardiel, Potrok Aike (Argentinean Patagonia; Anselmetti et al., 2009;

Gilli et al., 2005) and Lac d'Armor (Kerguelen Archipelago; Heirman et al., 2012), similar sediment drifts have been attributed to an intensification of the SWWB. Westerly winds blow surface waters to the Eastern extremities of the lakes, a process which is counteracted by bottom currents from East to West. In the Argentinian lakes the onset of wind-driven sediment drifting has been dated to 6.8 kyr BP (49°S) and 6.0 kyr BP (52°S). In the more northerly situated Lago Castor (45.6°S), this process started much earlier, i.e., shortly after the start of the deglaciation around 18.0 kyr BP.

Since then, wind strength has gradually increased, interrupted only by a decrease around the time of the Antarctic Cold Reversal (~13–14 kyr BP; end of unit D). Although some of the sediment-drift-architecture changes during the Holocene may also be influenced by variations in sediment supply (by, for example, high input of volcanic ashes, e.g. unit B), there appears to be an increase in sediment drifts during the last 3000 yrs (unit A), which we interpret as an increase in the strength of the SWWB.

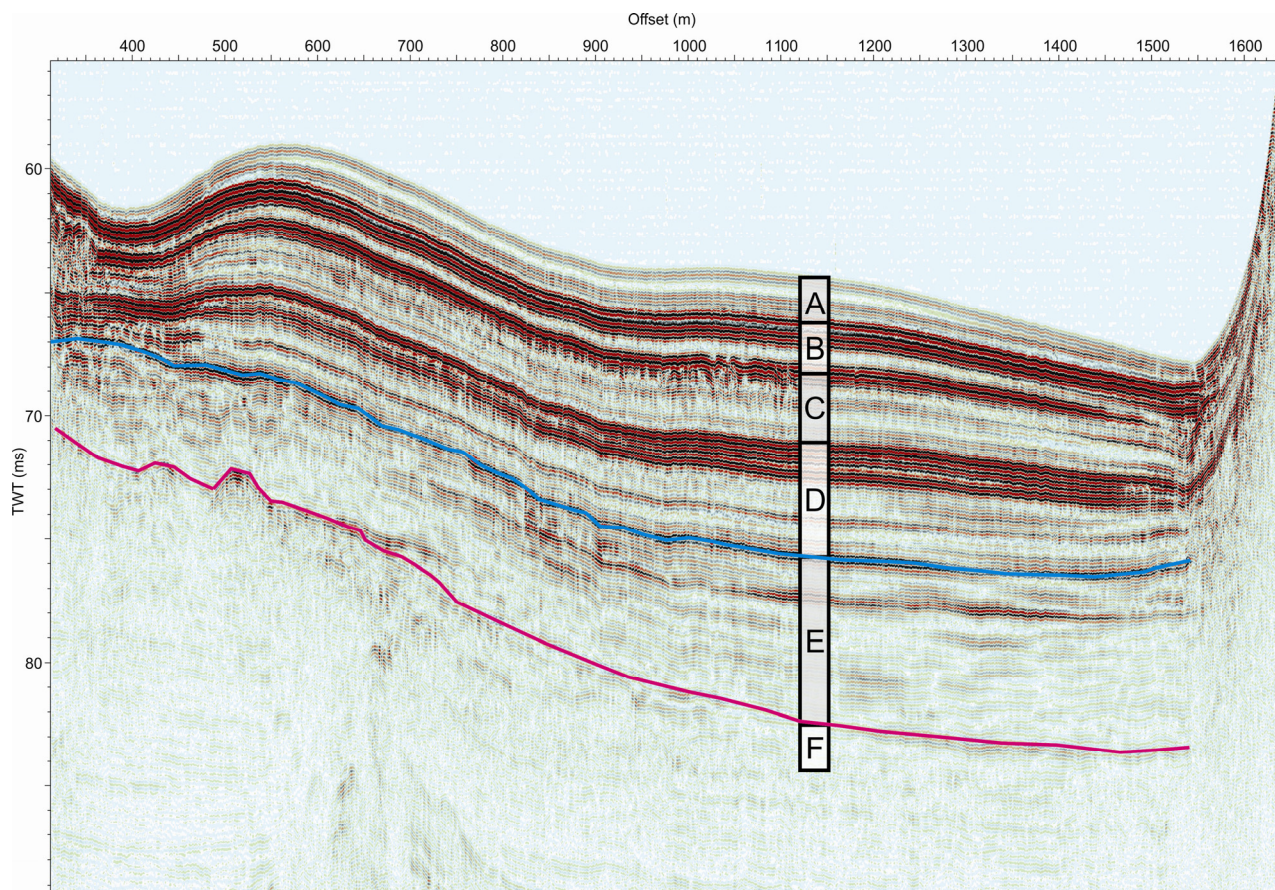


FIGURE 1. 3.5 kHz profile showing the different units of lacustrine infill of Lago Castor. The 15-m-long sediment core is projected on the profile.

CONCLUSIONS

The Lago Castor sediment drifts allow the reconstruction of changes in the intensity of the Westerlies since the LGM. Sediment drifts constitute a good and relatively poorly investigated proxy for Westerly wind strength reconstructions, which is independent from other sedimentological or biological proxies.

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